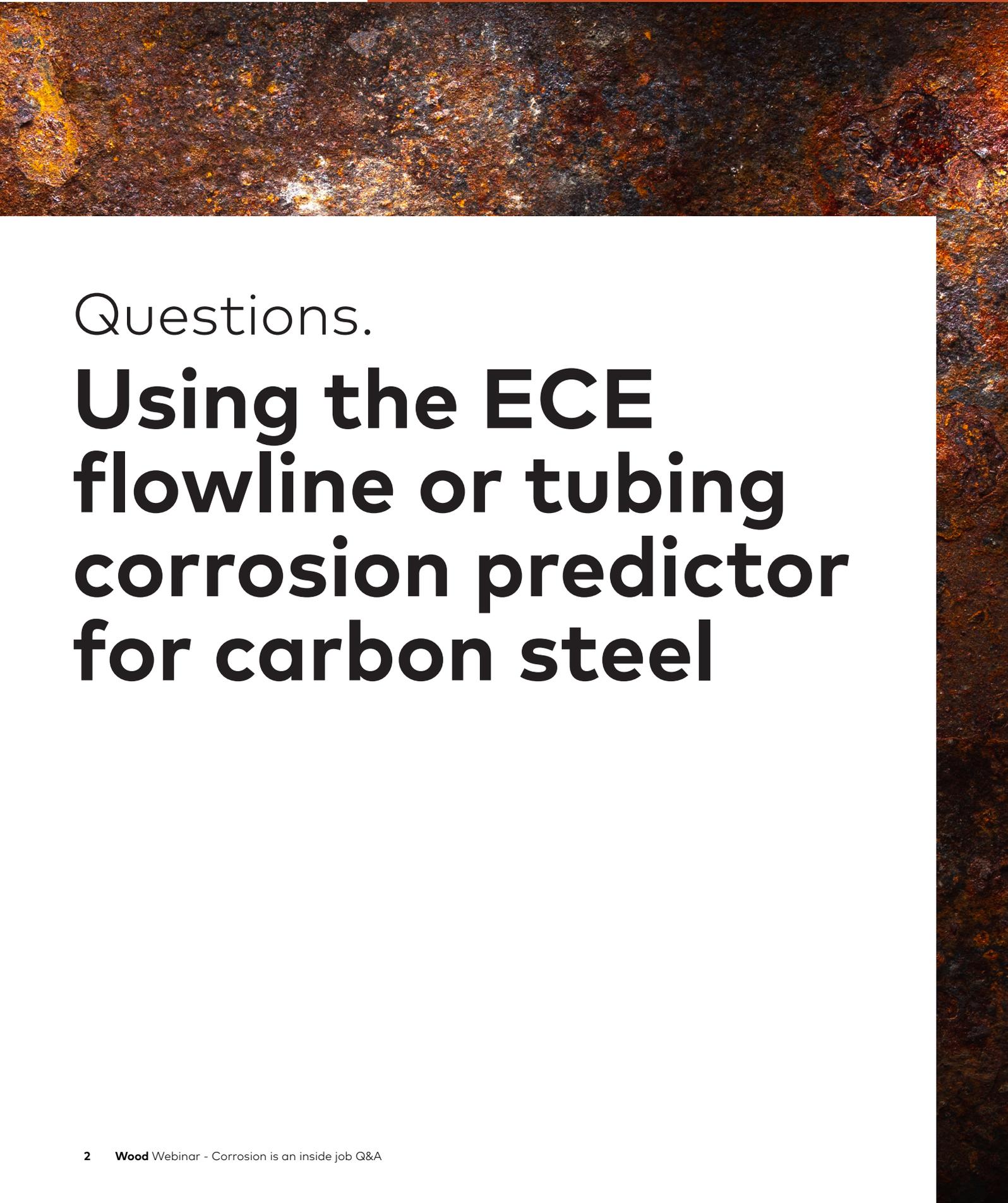


Corrosion is an inside job Q&A

wood.



A close-up photograph of a heavily rusted metal surface, showing various shades of brown, orange, and black. The rust is unevenly distributed, with some areas appearing more corroded than others. The texture is rough and granular.

Questions.

Using the ECE flowline or tubing corrosion predictor for carbon steel



If there is no internal corrosion expected, do I still need to do the calculations?

If the process is dry, then no, it is not normally required to conduct corrosion calculations for dry service, except to demonstrate what corrosion would be expected if the process became wet.

What input parameters should I use to model a wet gas pipeline which has no measurable flowrate of liquid water?

Two options:

- Most corrosion modelling packages, including ECE, require a minimum flow rate of water to be entered, so the typical approach is to set the liquid water flow rate to the minimum possible value.
- As a more conservative option, if you're presented with a composition of water in the vapor phase heat and mass balance the data, you can convert that into a condensed liquid and determine the maximum possible liquid water flow rate considering complete condensation of any water. That would be a worst-case scenario. If you compare that to the minimum flow rate, that will give you an indication of the spectrum.

If we have a CO₂ and H₂S concentration in the dissolved phase (ppmw) available upstream of the pump, can we use that composition for downstream of the pump as well with temperature and pressure from upstream for calculation?

Yes, that is exactly the correct approach.

How is H₂S corrosion or pitting addressed within the model?

In the event that H₂S is present, ECE gives the user a series of outputs:

- General corrosion rate that would be expected on the assumption of FeS film formation considering the relative ratios of CO₂ and H₂S present.
- Pitting corrosion rate which would occur in the event that the FeS film breaks down locally.

- Pitting risk factor as Low/Moderate/High/Very High which is a qualitative estimation of the stability of the FeS film under the operating conditions and hence a risk factor that pitting may occur.

When H₂O% is around 0.17%, but as a vapour, not a liquid, how do I get the flow rate?

You need to convert this % to a volumetric flow rate of water in a liquid state. There is usually sufficient detail in the H&MB dataset to do this calculation.

How do you calculate the water-cut?

This is just the volumetric % of water in oil. It is calculated by ECE by entering the respective oil and water flowrates.

If my project is downstream and the pipes will be used for gas injection only, shall I consider the crude oil flow rate = 0?

Yes, unless there is condensate expected. The entry is for liquid hydrocarbon in ECE, which may be crude oil or condensate.

Is the influence of iron sulphide also accounted for in sour service?

Yes, ECE models the formation of FeS films and also the stability of that film under the conditions entered. It provides the user with a general corrosion rate prediction, a pitting corrosion rate prediction that would occur following FeS film breakdown and also a qualitative stability ranking of the film.

Our client asked us to consider 3000ppm H₂S. I think they are concerned about the H₂S cracking. On the other side, the actual ppm is around 850ppm, which will have a big effect on the calculated corrosion rate. What would you recommend in this situation? (No possibility of any water phase in the process.)

You might find that the corrosion rate reduces with more H₂S; it is generally CO₂ content that drives the predicted corrosion rate. If the process is dry, then general or pitting corrosion is not a concern. While it may require sour service spec to resist cracking in the event of off-spec wet operation, the difference between 850ppm and 3000ppm would only be important if this is



for a CRA selection, for carbon steel selection as long as H₂S content is greater than 0.05psi, meaning it is classified as NACE sour service, then an increase H₂S makes no difference.

How does the ECE model consider the effects of protective iron carbonate films on the pipeline internal, especially at high pH or high temperature?

ECE applies an iron carbonate protective scaling factor to the underlying predicted corrosion rate in regions where iron carbonate is expected to form.

How does pipeline roughness affect corrosion?

There is only a small effect on the flow model and currently this is not a user definable input to ECE. However current developments on the flow model will allow entry of surface roughness values to future versions of ECE.

I am only interested in looking at corrosion for a single point in a pipeline, how should I set up the inlet and outlet temperature and pressures correctly to do this in ECE?

You can just synchronise them to be the same, and ECE will do that for you, or you can use the bulk upload spreadsheet, which is just a point calculation tool.

What is the main difference between the ECE model and some of the free spreadsheets that are available such as NORSOK and Cassandra in terms of capabilities?

The primary difference is that those free spreadsheets do not take account of H₂S present.

NORSOK has some very small PPM values of where H₂S is acceptable, whereas ECE is a model that fully evaluates the presence of both CO₂ and H₂O on your conditions.

Would ECE work for instrumentation tubing?

ECE wouldn't be applicable to predicting corrosion rates for instrumentation tubing, as the minimum diameter which may be considered is about 3". Additionally, the NACE CRA selections rules incorporated into ECE are for "any equipment," they are not applicable to instrumentation tubing, which has separate rulesets in the standard.

What is the effect of 'low spot water drop' and 'enable holdup change' in terms of corrosion rate value?

Checking low spot water drop out switches off the oil wetting model within ECE, and any protective effect by the presence of oil is removed.

Liquid hold up change is related to the difference in the flow velocity between liquids and gases in a pipeline with the gas flowing faster. It may overtake the water, and the cross-sectional area of water in a pipe increases as it is "held up." This change parameter enables that to be adjusted over the length of the pipeline being modelled.



Have correlation studies been carried out to examine the accuracy of the modelling results against the real data in the field?

Yes, correlation studies have been performed and published. These are available upon request.

Do you plan to include oxygen corrosion prediction in future versions? Such a feature could help in tubing selection for injection wells.

This is a possible upgrade in a future version of ECE.

Can slugging in pipelines be modelled, and how does it affect corrosion?

Yes, slug flow is a potential flow pattern that may be predicted by the ECE flow model. The primary impact would be the change in the flow velocity in the event of slug flow as this is an input to the corrosion rate prediction model.

Is there any way to model bends and drops in pipes or fluid containing sediments such as sand which will cause internal erosion or corrosion?

In a word, no, although the flowline model allows for a pipeline section to be elevated, corrosion modelling isn't sufficiently advanced to model corrosion within piping bends to that detail.

However, with regards to erosion, we do include it within the tubing model an implementation of the DNV RP-0501 erosion standard to evaluate potential solids erosion rates in the event of downhole sand production.

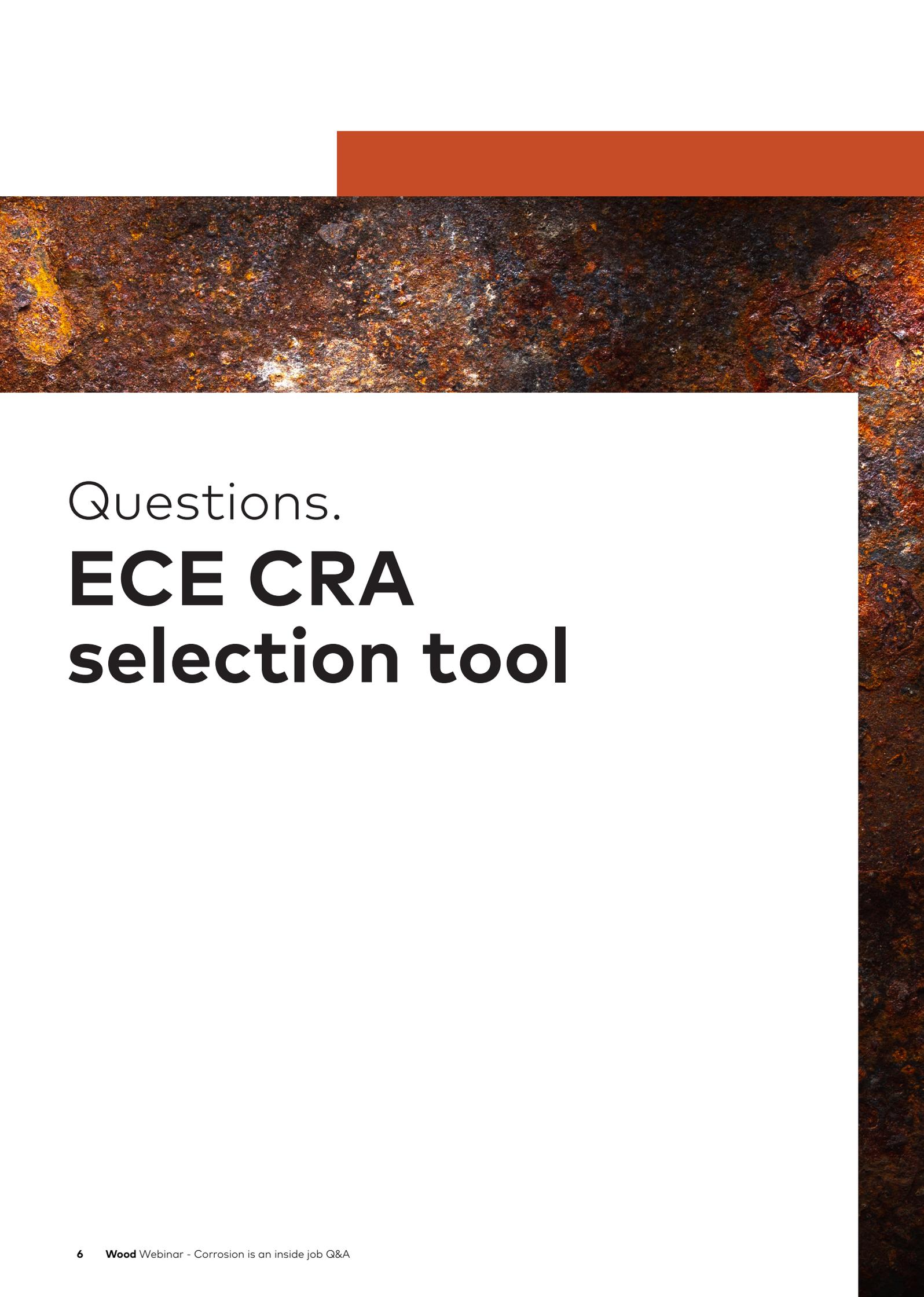
What is your opinion on corrosion inhibitors for gas system?

Corrosion inhibition of gas systems must be used with care. The design of the system needs to consider a good distribution of the inhibitor over the internal surface, which is more difficult in the absence of liquids flow.

Multiple injections points and the use of atomising quills and oil-soluble chemicals, which may be transported in any liquid condensate, are typical practices employed in gas systems.

With corrosion inhibitors for gas systems, do you consider 95% efficiency?

Efficiency of over 99% can be measured in lab tests, however, the value is specific to the chemical and the environment, and only laboratory testing can determine what it is.



Questions.

ECE CRA selection tool



For CRA, what is the difference between 316L clad and 316L?

The difference between SS316L and SS316L clad is that the clad option is an internal cladding of a carbon steel pipe, and hence the external surface would be carbon steel. A solid SS316L pipe would have an external SS316L surface, and hence different external damage mechanisms would be applicable. However, for the internal environment, they are the same.

In the CRA evaluator, does the ECE result consider corrosion of CRAs as well as cracking? Does ECE consider critical pitting temperatures for CRA?

Yes, the ECE rules for 13Cr, Duplexes and SS316 are applied to resistance to general and localised corrosion mechanisms in sweet service. Although the conditions have to be quite extreme to get anything but a green light for SS316 and Duplex materials in sweet service.

For the other alloys 6Mo , 825 and 625 the rules are for resistance to sour cracking.

The reference details and domain maps for ECE rules can be found in the help guide.



Question.

ECE lifecycle costing tool



Does ECE's lifecycle cost analysis tool consider the mechanical code specification and available standard thickness to compare CRA with CS? Sometimes, codes require a minimum or specific thickness regardless of calculation from design conditions.

The lifecycle cost calculator allows these values of wall thickness to be entered by the user. ECE does not calculate mechanical thickness requirements.

For further information please go to:

woodplc.com

